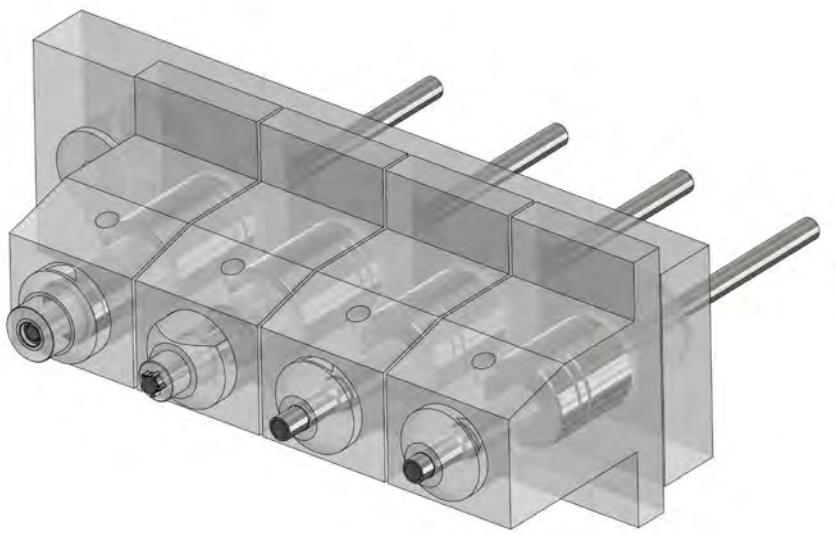
Designing for manufacture

Thinking about manufacturing and assembly earlier in the design process leads to better, more profitable products.

Faced with a complex problem, it is natural for engineers to focus first on function. They want to find a solution that meets its operational requirements, then they worry about hitting manufacturing cost targets.

Too often, however, that approach can lead to sub-optimal solutions. Products that are expensive or difficult to manufacture are less profitable for their makers. In the worst cases they may fail altogether. Some of the world's most successful companies have been tripped up by high manufacturing costs. Dyson, market leader in high-end vacuum cleaners, abandoned its first venture into the domestic laundry market after five years, for example. Its contra-rotating tub design offered good cleaning performance, but its complexity resulted in manufacturing costs that the company couldn't sustain[1]. Similarly, when it's fifth generation of its highly popular Golf model proved too expensive to build, carmaker VW was forced to launch a wide-ranging cost reduction program.



Punch Block System on a 5 Station Cold Heading Machine

Addressing product cost problems in the run-up to production is notoriously difficult. As a rule of thumb, 70 percent of the cost of a final product is fixed during the design phase. That leaves little room for manoeuvre if the design fails to meet its cost target. It's also why leading companies are increasingly trying to focus on manufacturing and assembly considerations earlier in the product development lifecycle.

Design for manufacture (DFM) is a complex topic, involving trade-offs between numerous potentially conflicting product attributes. There are a number of well-established guidelines that can help companies make better early lifecycle decisions, however.

Reduce the number of parts

A product made from fewer parts usually takes less time to assemble and costs less than one made with more. Reducing overall part count has benefits away from the production line too – simplifying purchasing, inventory management and version control.

Part count reductions can be achieved in a number of different ways. Manufacturing technologies such as injection moulding, precision cold forming, CNC machining, investment casting or 3D printing allow complex geometries that can reduce or eliminate the need for additional components like brackets or fasteners. Designing one part to perform multiple functions, like a casing that also operates as a heat sink, can also reduce overall part count.

Standardise

Using components that can be bought off the shelf cuts in-house design and testing costs, allows companies to

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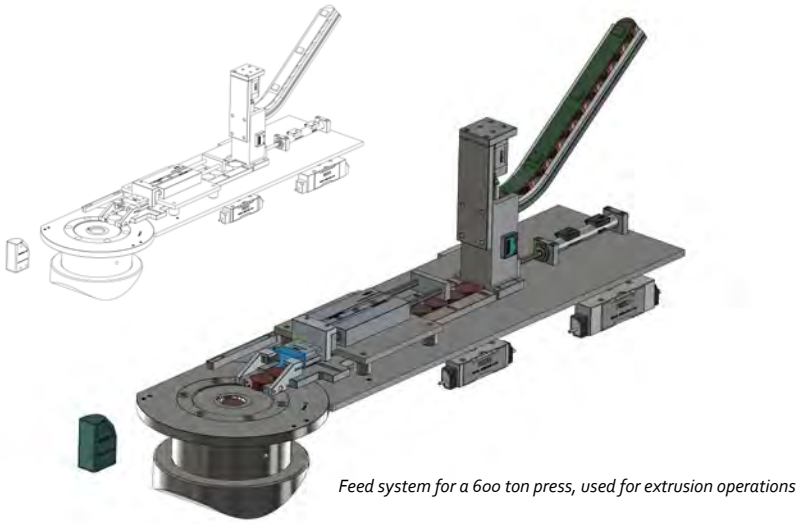


Feed system for a 600 ton press, used for extrusion operations

benefit from economies of scale and reduces supply risks, especially if the component is available from multiple sources.

Standardisation doesn't have to be limited to externally sourced parts, however. Product designs can encourage internal standardisation, for example, by replacing separate left and right-handed components with identical, but reversible designs. The use of modular designs, common platforms and internal standards also allows companies to share parts among different products, with similar scale and simplicity benefits.

Consider assembly

Simplifying and accelerating the assembly of product saves cost on the production line, and reduces errors that can lead to expensive quality problems later on. Good practice in design for assembly includes: ensuring products can be assembled from as few directions as possible – ideally only from above; including guides and stops to ensure parts sit easily in the right locations; and reducing the sensitivity of the design to component and assembly tolerances. Other useful strategies include using parts that are either perfectly symmetrical, so they can be fitted either way up, or highly asymmetrical, so the correct assembly orientation is clear. Where automated or robotic assembly is to be used, consideration should be given to how parts are stored and presented to the assembly equipment, and how they will be handled by it.

Understand process constraints

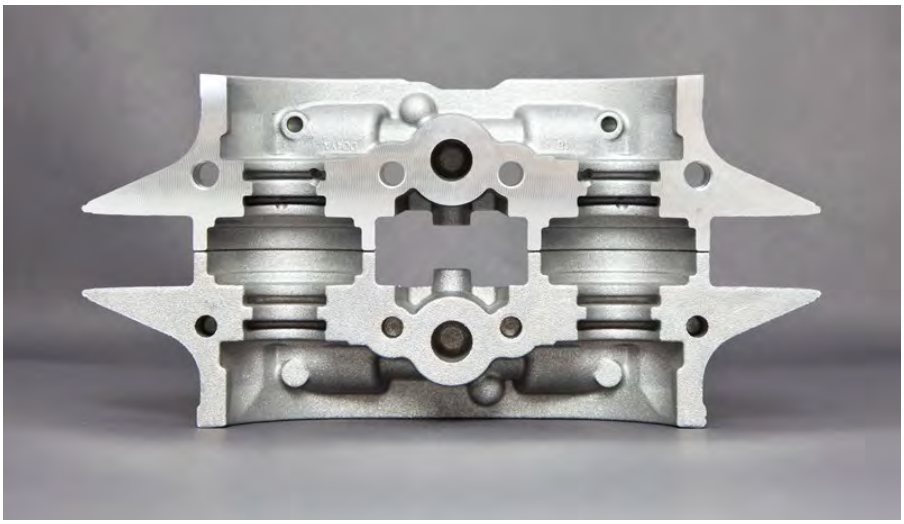
A key challenge for engineers not specialised in a particular manufacturing technology lies in optimising their designs to suit the capabilities of the chosen manufacturing process.

Sometimes, they may not even realise that a particular process is suitable for their parts. Processes vary in their ability to reproduce features, like thin walls or tight bend radii, and the production process can even affect the mechanical properties of the finished material. Details of part geometry can have a big impact on the cost of tooling, production cycle times and the ability of the part to resist shrinkage or distortion after manufacture. Finishing and surface treatment requirements can vary dramatically, something that can have a significant effect on the final cost of the part. Another important process consideration from a cost – and environmental – perspective is waste. Some processes, like machining from solid, mean a large percentage of the raw material is turned to scrap.

Other techniques, including forging and cold forming, can achieve much higher levels of material utilisation.

Use the right tools

While there is no substitute for experience and expertise, modern design support tools can provide considerable assistance to companies seeking to improve the manufacturability of their designs, or to evaluate the relative cost of different manufacturing approaches during early stage product development.



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Italy Precision CNC Machining Inc.

Manufacturability evaluation modules, available for a number of modern CAD systems, can automatically detect features, such as holes, ribs and draft angles, and check them against a database of constraints associated with different manufacturing processes. Specialist software is available to allow "clean sheet" cost estimates of parts made using different technologies, or to estimate manufacturing and assembly cycle times and labour requirements.

Ask the experts

Early input from process experts can be invaluable in assessing the viability of different manufacturing approaches, and specialists can often suggest design changes that will reduce cost or improve quality in the final design. Few companies today have internal expertise across a full range of manufacturing technologies, which is why suppliers and contract manufacturers are playing an increasingly important role in these early stage discussions. Manufacturing specialists from Italy Precision, for example, are always happy to discuss concepts and share details of the capabilities and constraints of their processes (see box: An injection of manufacturing expertise).

Disruptive thinking leads to better design

Vacuum Interrupters are used throughout the power generation sector, providing a proven and reliable method of protecting high voltage components.

Traditionally these parts have been manufactured from solid copper rod, machined to shape with a flat section to prevent the component rotating when in use. This approach, however, reduces the cross section of the part and adversely affects its electrical properties.

Working with our customer, we took a radically different approach to the design and manufacture of the part. This involved changing the production process from machining to cold forming. This reduced unit cost and enabled parts with improved surface finish and mechanical strength to be produced in a single operation, and in high volumes. It also enabled four anti-rotation splines to be extruded along the length of each component, giving increased surface area for improved cooling and conductivity.

About Italy Precision

With over 60 years' experience in precision engineering, Italy Precision has partnered with customers in almost every sector of industry, from automotive and motorsports to aviation, power distribution, electronics and medical.

We have the knowledge, skills and resources to engineer innovative solutions from one-off parts to high volume components. In particular, we specialise in cold forming and machining in many different metals, including copper, aluminium and ferrous, plus a variety of exotic materials.

We offer:

- A total service, from design and prototyping, with advice on best manufacturing practices, through pre-production to high or low volume supply
- A proactive approach with technical and commercial advice to help you find the best solution at optimum cost
- 24 hour production with a flexible and friendly service
- Advanced 3D solid modelling systems for fast component development
- Extensive engineering facilities, with both cold forming and precision machining shops to provide manufacturing flexibility to meet your exact needs
- Dedicated logistics support to ensure delivery where and when you require, anywhere in the world, including Kanban, just in time (JIT) and consignment stock

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